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ITU-T Y.4604 (09/2023)

SERIES Y: Global information infrastructure, Internet protocol aspects, next-generation networks, Internet of Things and smart cities

Internet of things and smart cities and communities – Services, applications, computation and data processing

Metadata for camera sensing information of autonomous mobile Internet of things devices

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Recommendation ITU-T Y.4604

Metadata for camera sensing information of autonomous mobile Internet of things devices

Summary

Recommendation ITU-T Y.4604 specifies metadata for camera sensing information (MCSI) and describes characteristics and features of individual pieces of MCSI working on autonomous mobile Internet of things (IoT) devices.

In the case of low-cost and low-resolution IoT camera sensor devices, it is not possible to support full-featured camera sensing information due to their resource-limited capabilities. Traditional full-performance digital camera devices provide complex metadata such as camera settings (stimulus, sensitivity, shutter speed, etc.), time, location information and camera model.

There is no guidance for compliant and compromised IoT camera-sensing metadata from different manufacturers. This causes problems related to interchangeable metadata. It is essential therefore to provide basic and minimal camera-sensing metadata to enable interoperability between IoT applications and services.

History *

Edition	Recommendation	Approval	Study Group	Unique ID
1.0	ITU-T Y.4604	2023-09-13	20	11.1002/1000/15480

Keywords

IoT autonomous mobile device, IoT image sensor, metadata, sensing information.

* To access the Recommendation, type the URL https://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID.

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NOTE

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Metadata for camera sensing information of autonomous mobile Internet of things devices

1 Scope

This Recommendation specifies metadata for camera sensing information (MCSI) and describes details of characteristics and features of MCSI working on autonomous mobile Internet of things (IoT) devices (AMIDs).

In particular, the scope of this Recommendation includes:

– sensing methods and data structure for MCSI;

– specification of characteristics and features of individual pieces of MCSI.

NOTE 1 – Regulation-related information metadata, such as privacy, personally identifiable information and face recognition, lie outside the scope of this Recommendation.

NOTE 2 – This Recommendation is not intended to apply to all vehicles, environments or applications, but does apply primarily to sensors for aviation or unmanned aircraft system devices and delivery service robots.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

None.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 application [b-ITU-T Y.2091]: A structured set of capabilities, which provide value-added functionality supported by one or more services, which may be supported by an API interface.

3.1.2 device [b-ITU-T Y.4000]: With regard to the Internet of things, this is a piece of equipment with the mandatory capabilities of communication and the optional capabilities of sensing, actuation, data capture, data storage and data processing.

3.1.3 Internet of things (IoT) [b-ITU-T Y.4000]: A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies.

NOTE 1 – Through the exploitation of identification, data capture, processing and communication capabilities, the IoT makes full use of things to offer services to all kinds of applications, whilst ensuring that security and privacy requirements are fulfilled.

NOTE 2 – From a broader perspective, the IoT can be perceived as a vision with technological and societal implications.

3.1.4 metadata [b-ITU-T Y.1901]: Structured, encoded data that describe characteristics of information-bearing entities to aid in the identification, discovery, assessment and management of the described entities.

3.1.5 smart sustainable city [b-ITU-T Y.4900]: A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental, as well as cultural aspects.

3.1.6 terminal device (TD) [b-ITU-T Y.1901]: An end-user device which typically presents and/or processes the content, such as a personal computer, a computer peripheral, a mobile device, a TV set, a monitor, a VoIP terminal or an audio-visual media player.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 metadata camera sensing information (MCSI): A metadata of sensing information captured from an Internet of things camera sensor.

4 Abbreviations and acronyms

This Recommendation uses the following terms and abbreviations:

AMID Autonomous Mobile Internet of things Device

API Application Programming Interface

AR Augmented Reality

BIM Building Information Modelling

EO Electro-Optical

EXIF Exchangeable Image File Format

GNSS Global Navigation Satellite System

ICT Information and Communication Technology

IoT Internet of Things

IR Infrared Radiation

JPEG Joint Photographic Experts Group

LiDAR Light Detection and Ranging

MCSI Metadata Camera Sensing Information

MSI Multispectral Image

TD Terminal Device

TIFF Tagged Image File Format

TV Television

VoIP Voice over Internet Protocol

VR Virtual Reality

5 Conventions

None.

6 Introduction

In general, traditional full-performance digital camera devices provide a lot of metadata including information such as camera settings (stimulus, sensitivity, shutter speed), time, location information and camera model. For example, for image file formats, there are exchangeable image file format (EXIF) metadata formats such as Joint Photographic Experts Group (JPEG) and tagged image file format (TIFF). EXIF is a format that stores metadata containing information about images or voice files acquired by digital cameras, including image size, file format, resolution, and camera information such as focal distance, brightness and exposure time. The EXIF format provides complicated and full-featured camera sensing information [b-Exif].

However, in the case of low-cost and low-resolution IoT camera sensor devices, it is not necessary to support full-featured camera sensing information in resource-limited device capabilities. Additionally, there is no guidance currently for compliant and compromised metadata from different manufacturers. Therefore, it is crucial to provide guidance for basic and minimal sensing metadata of IoT camera sensors to enable interoperable IoT applications and services. Consequently, this Recommendation focuses on describing the basic metadata that are essentially required in such environments. Such metadata allow developers to launch IoT application services, and can be complemented with interoperability and provided without conflicting with existing metadata such as EXIF.

An AMID is a type of IoT device with an embedded or connected IoT sensor camera. AMIDs such as delivery service robots, home appliances (robot vacuum cleaners, etc.), and autonomous driving cars are already becoming common in the IoT services market. Recent AMIDs with cameras including different metadata (location, angle of view, temperature, time, etc.) cannot support compliant metadata among different device manufacturers in the market. AMIDs also experience problems due to the lack of common metadata on image sensor information, differences in specifications (units, resolution, criteria, etc.) and specific metadata that are dependent on manufacturers.

Concerning AMIDs, it is important to avoid non-compliant metadata processing while capturing camera sensing information. By standardizing IoT camera sensing metadata, the metadata conflict problem can be resolved and development costs of interoperable data standards for IoT camera-based devices reduced. This standardized IoT camera sensing metadata can be used as a foundational metadata for IoT camera-based services, such as autonomous robot services, building management services and augmented reality or virtual reality (AR/VR) services. Autonomous mobile IoT services can demand metadata of image and video data and these metadata can be applied for various application services. In most IoT application services, these metadata can be combined and applied for visualizing and 3-dimensional spatial information generation.

Figure 6-1 shows an example of a service environment of AMIDs.

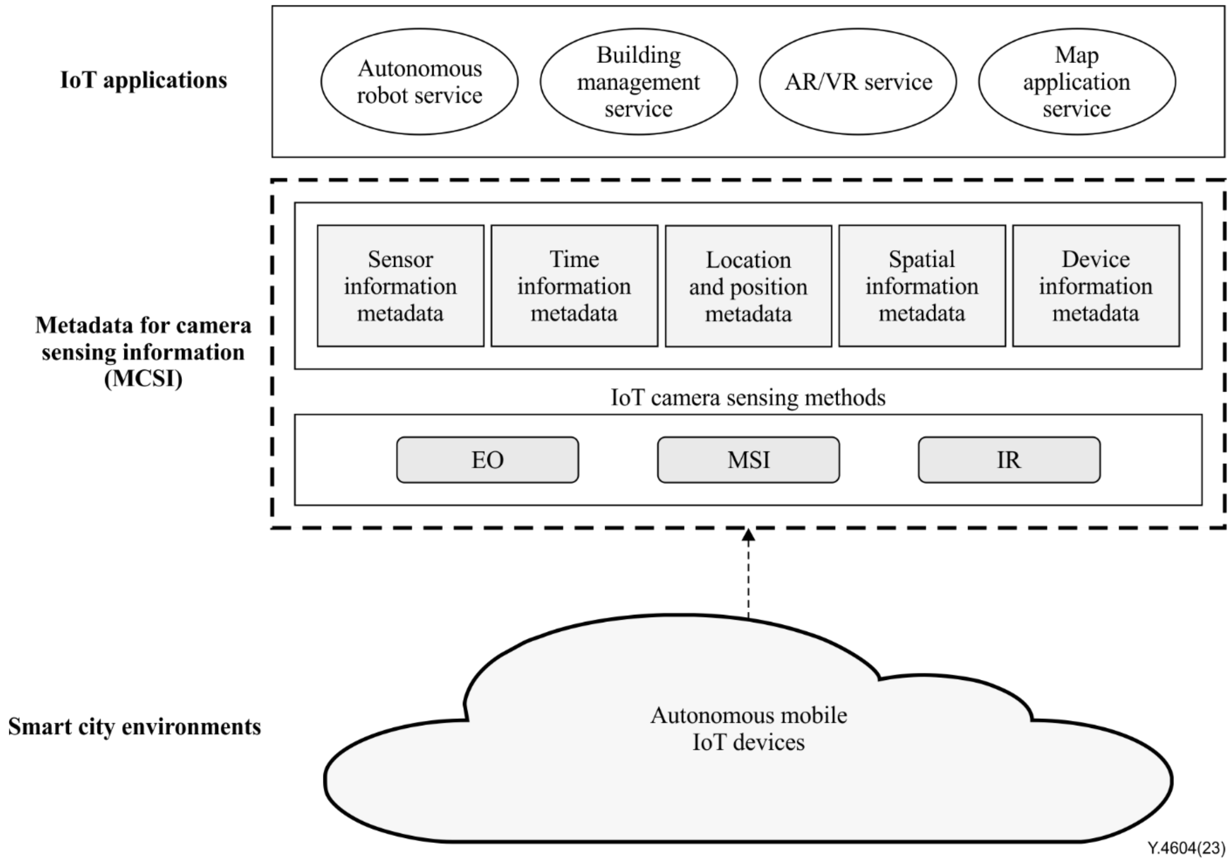

Figure 6-1 – Example of a service environment of autonomous mobile IoT devices

7 General MCSI metadata characteristics

This clause describes the characteristics of camera sensing and the data structure on which MCSI metadata is based.

7.1 Sensing methods for MCSI

IoT camera sensing devices vary and have different characteristics according to sensing types. In general, typical sensing data types include methods such as electro-optical (EO), infrared radiation (IR), multispectral image (MSI), and light detection and ranging (LiDAR) [b-ISO 19130-1].

EO image data digitally acquires images up to a visible light area and an infrared area based on a charge-coupling element. This sensor provides better results than optical sensor data in long-distance and low-clock situations and is the most commonly used sensor.

IR thermal image data detects IR energy emitted by the target to measure the surface temperature of the target. This sensor is characterized in that it maps colours according to the measured temperature value to configure a screen, thereby providing an identification power that EO data cannot provide.

MSI data protect wavelength-specific images divided into about 10 bands in the band of visible or near infrared spectrum. This sensor has fewer bands than hyperspectral data and has a relatively low price compared to hyperspectral sensors. Hyperspectral data also protect all wavelength-specific images subdivided into hundreds to thousands of continuous spectral bands in a narrow band of the near-infrared or intermediate infrared spectrum. This sensor can identify unique components of the target and provides more detailed interpretation information because it has a higher spatial or spectral resolution than a multispectral sensor.

LiDAR image data analyse reflected light by irradiating a target with a laser. This sensor is likely to be used in various fields for storing distance, direction, speed, temperature, and characteristic data.

A gimbal reduces movement vibration to prevent deterioration of the quality of the captured image. By providing metadata such as the photographic angle of the camera or sensor, additional meaning may be added to the acquired image data.

7.2 Data structure for MCSI

This clause explains the data structure used in this Recommendation. This Recommendation aligns with the existing metadata standard format. Table 1 describes the data structure of the MCSI metadata in order to explain features for understanding this Recommendation. The table includes the tag name, a description, and M (mandatory) and O (optional) support levels respectively. It also lists attributes including the unit, the minimum value and maximum value, the exception value, and the resolution, as well as an example and notes.

Table 1 – MCSI description format used in this Recommendation

<table>
<tr><td>Tag name</td><td colspan="4">–</td></tr>
<tr><td colspan="4">Description</td><td>Support level (M/O)</td></tr>
<tr><td colspan="4">–</td><td>–</td></tr>
<tr><td>Unit</td><td>Min value</td><td>Max value</td><td>Exception value</td><td>Resolution</td></tr>
<tr><td>–</td><td>–</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>Example</td><td colspan="4">–</td></tr>
<tr><td>Note</td><td colspan="4">–</td></tr>
</table>

8 MCSI metadata elements

This clause specifies common and basic camera sensing metadata for IoT camera-based services.

8.1 Sensor information metadata

8.1.1 EO sensing type

The sensor specifies a sensor identifier that acquires sensing data. The type, model name, attachment position, etc. of the sensor may be described. It provides important functions in the distribution of sensing data because the characteristics and specifications of sensing data that can be acquired vary depending on the characteristics and specifications of the sensor.

The sensor information acquired by an AMID depends on the support information of the sensor itself. For example, the geographic area information included in the acquired image may be calculated only when combined with position posture information.

The field of view is an angle at which the sensor can hold an image. When the angle of view, position, and posture information are combined, geographic range information included in the image may be calculated by assuming the altitude as being sea level.

Table 2 – MCSI EO sensing type for sensor information

Tag name	Image.Model			
Description				Support level (M/O)
Specifies a sensor identifier that acquires sensing data. The type, model name, attachment position, etc.				O
Unit	Min value	Max value	Exception value	Resolution
–	–	–	–	–
Example	–			
Note	–			

Tag name	FieldOfView			
Description				Support level (M/O)
Angle of view of the sensor				M
Unit	Min value	Max value	Exception value	Resolution
°	0	180	−1	~2.7×10^{-3}°
Example	72.481 2°			
Note	Vertical angle is specified as proportional to horizontal angle. When the angle information is not obtained, a special value (−1) is used.			

8.1.2 MSI sensing type

The MSI still image metadata is limited to a still image processed to transmit sensor data acquired by a spectroscopic sensor to a human visual. The MSI sensor metadata includes the definition of the EO still image metadata item, the support level and the geographic reference model, and additional MSI still image fields are added and specified for interpretation.

The spectral sensor measures a value for each wavelength band by dividing the visible light spectrum into several wavelength bands. If the number of wavelength bands to be divided is small, it is divided into multi-spectral, if large, hyper-spectral, and IR sensors are also included in the multi-spectral sensor.

Since the spectroscopic sensor provides a measured value for each divided area by dividing a visible light area within a given measurement range, a sensor standard should be referred to for analysis of the sensed data itself. A sensor standard should also be referred to even when processed into an image.

As previously described, the spectral sensor measures by dividing the visible light area, and the measurement performance is determined according to the number of bands that can be divided and the range of spectra that the sensor can measure. The spectral range means the range of wavelengths that sensors can detect.

MSI information is a reference for the spectral range within the acquired image itself. Information and names of spectral ranges (bands) set to acquire each image are specified. Each pixel in the image has a measured value within an actually divided spectral range, and the arrangement of colours varies according to the visualization method. Table 3 describes the MCSI MSI sensing type for sensor information.

Table 3 – MCSI MSI sensing type for sensor information

Tag name	MaxNumberOfBands			
Description				Support level (M/O)
Number of measurable bands (spectral bands)				O
Unit	Min value	Max value	Exception value	Resolution
–	1	150	0	1
Example	6			
Note	Number of bands can be measured by dividing the visible light area. Since the image sensor has at least one band, the special value (0) means that a value cannot be input.			

Tag name	CentralWavelength			
Description				Support level (M/O)
Centre wavelength value in the image (band)				O
Unit	Min value	Max value	Exception value	Resolution
nm	–	–	0	10
Example	500 nm			
Note	It is specified in units of micro- or nanometres. If a value cannot be input, a special value (0) is used.			

Tag name	BandWidth			
Description				Support level (M/O)
Bandwidth in an image (band)				O
Unit	Min value	Max value	Exception value	Resolution
nm	–	–	0	10
Example	50 nm			
Note	Determines the size (bandwidth) of the band around the central wavelength. For example, if the central wavelength is 500 nm and the bandwidth is 50 nm, the band has a spectral range of 450 to 550 nm. Use a special value (0) if a value cannot be entered.			

Tag name	BandName			
Description				Support level (M/O)
Band name in image (band)				O
Unit	Min value	Max value	Exception value	Resolution
–	3	127	000	–
Example	Red, Green, Blue, RedEdge, NIR			
Note	The name of each band is expressed as a string. For example, major bands commonly used in the industry include red, green, blue, red edge, near infrared (NIR), as well as short wavelength infrared, medium wavelength infrared, long wavelength infrared and far infrared. When a band name is not separately specified, it is expressed as a special value ("000").			

8.1.3 IR sensing type

The IR sensor provides a value measured within the range of the sensor's own standard for infrared rays within a given screen range. The IR sensor metadata includes the definition of the EO still image metadata item, the support level and the geographic reference model, and additional IR still image fields are added and specified for interpretation. In order to interpret the IR sensor data itself, it is necessary to refer to the sensor specification and to refer to it even when processed into an image. The main items corresponding to this are described in Table 4.

IR image information is a reference for the temperature range within the acquired image itself. Each pixel in the image has a value expressed by mapping a colour to an actual measured temperature value, and the arrangement of colours varies according to the visualization method. The maximum and minimum values of the temperature expressed by each pixel of the image are specified as metadata items.

Table 4 – MCSI IR sensing type for sensor information

Tag name	SensorNEDT			
Description				Support level (M/O)
Thermal sensitivity of IR sensors				O
Unit	Min value	Max value	Exception value	Resolution
millikelvins (mK)	5	–	−1	–
Example	50 mK (0.05°C)			
Note	Thermal sensitivity of the thermal image camera, and may be confirmed through signal-to-noise generated when the same signal is generated. When a value cannot be input, a special value (−1) is used.			

Tag name	SensorTemperatureRangeMax			
Description				Support level (M/O)
Maximum temperature value that an IR sensor can measure				O
Unit	Min value	Max value	Exception value	Resolution
°C (Degree)	−50	1500	−1500	5×10^{-3}°C
Example	52.325°C			
Note	For the resolution of the highest temperature value that the IR sensor can measure, refer to SensorNEDT. When a value cannot be input, a special value −1 500 is used.			

Tag name	SensorTemperatureRangeMin			
Description				Support level (M/O)
Minimum temperature value that an IR sensor can measure				O
Unit	Min value	Max value	Exception value	Resolution
°C (Degree)	−50	1500	−1500	5×10^{-3}°C
Example	52.325°C			
Note	For the resolution of the lowest temperature value that the IR sensor can measure, refer to SensorNEDT. When a value cannot be input, a special value −1500 is used.			

Tag name	SensorSpectralRangeMax			
Description				Support level (M/O)
Maximum wavelength detectable by IR sensors				O
Unit	Min value	Max value	Exception value	Resolution
µm	0.75	1000	−1000	25×10^{-3} µm
Example	1.25 µm			
Note	Most IR sensors that can be mounted on a TD have a range of 1 to 14 µm, and this Recommendation specifies the entire IR band to be representable. If a value cannot be input, a special value (−1000) is used.			

Tag name	SensorSpectralRangeMin			
Description				Support level (M/O)
Minimum wavelength detectable by IR sensors				O
Unit	Min value	Max value	Exception value	Resolution
μm	0.75	1000	−1000	25×10^{-3} μm
Example	1.25 μm			
Note	Most IR sensors that can be mounted on a TD have a range of 1 to 14 μm, and this Recommendation specifies the entire IR band to be representable. If a value cannot be input, a special value (−1 000) is used.			

Tag name	ImageTemperatureRangeMax			
Description				Support level (M/O)
Maximum temperature value in the image				O
Unit	Min value	Max value	Exception value	Resolution
°C (Degree)	−50	1500	−1500	5×10^{-3}°C
Example	52.325°C			
Note	The resolution of this value is referred to SensorNEDT.			

Tag name	ImageTemperatureRangeMin			
Description				Support level (M/O)
Minimum temperature value in the image				O
Unit	Min value	Max value	Exception value	Resolution
°C (Degree)	−50	1500	−1500	5×10^{-3}°C
Example	52.325°C			
Note	The resolution of this value is referred to SensorNEDT. When a value cannot be input, a special value −1500 is used.			

8.2 Time information metadata

Time information such as image generation, photographing and storage time is necessary for image generation. Most have an optional support level and include time information, such as image.date, photo.datetime.original, photo.datetime.digitized, TimeStamp and DateStamp. Table 5 describes MCSI for time information.

Table 5 – MCSI for time information

Tag name	Description	Support level (M/O)	Note
Image.Date	Image creation date and time	O	
Photo.DateTimeOriginal	Date and time of shooting	O	
Photo.DateTimeDigitized	File storage date and time	O	
TimeStamp	UTC time	O	
DateStamp	UTC time	O	

8.3 Location and position information metadata

Location and position information describes the position and attitude of the IoT device. In order to calculate the spatial information of the still image, not only the device but also the attitude of the sensor mounted on the device is required.

The location and position information in Table 6 is specified to have the same unit and value range and resolution, and the altitude and position are specified using a coordinate system. Table 6 describes MCSI for location and position information.

Table 6 – MCSI for location and position information

Tag name	AbsoluteAltitude			
Description				Support level (M/O)
Absolute altitude of the sensor measured based on the average sea level				O
Unit	Min value	Max value	Exception value	Resolution
M	−900	19 000	−19 000	~0.3 m
Example	150.00 m			
Note	Feet may be used, but metres are used in this Recommendation. When an altitude value is not input, a special value (−19 000) is used.			

Tag name	RelativeAltitude			
Description				Support level (M/O)
Relative elevation of the sensor measured based on the lower surface closest to the gas containing the ground surface.				O
Unit	Min value	Max value	Exception value	Resolution
M	−900	19 000	−19 000	~0.3 m
Example	150.00 m			
Note	Feet may be used, but metres are used in this Recommendation. When an altitude value is not input, a special value (−19 000) is used.			

Tag name	FlightYawDegree			
Description				Support level (M/O)
Yaw angle (heading) value of device				M
Unit	Min value	Max value	Exception value	Resolution
° (Degree)	0	360	−360	$\sim 5.5 \times 10^{-3\circ}$
Example	159.974 365°			
Note	The angle formed by the north direction and the device base direction is measured clockwise, with 0° in the north direction, 180° in the south direction and 270° in the west direction. When a value cannot be input, a special value (−360) is used.			

Tag name	FlightPitchDegree			
Description				Support level (M/O)
The pitch angle value of the device				M
Unit	Min value	Max value	Exception value	Resolution
° (Degree)	−20	20	−360	$\sim 610 \times 10^{-6\circ}$
Example	−0.431531724°			
Note	The angle formed by the device base direction (flex axis) and the horizontal plane is measured, with a positive value above and a negative value below. When a value cannot be input, a special value (−360) is used.			

Tag name	FlightRollDegree			
Description				Support level (M/O)
Roll angle value of the device				M
Unit	Min value	Max value	Exception value	Resolution
° (Degree)	−50	50	−360	$\sim 1525 \times 10^{-6\circ}$
Example	−3.405 865 66°			
Note	The angle formed by the horizontal plane and the horizontal plane of the fuselage from the cross-section of the device is set to a positive angle so that the right wing falls below the plane. When a value cannot be input, a special value (−360) is used.			

Tag name	GimbalYawDegree			
Description				Support level (M/O)
Sensor's relative yaw angle relative to device (Heading) value				M
Unit	Min value	Max value	Exception value	Resolution
° (Degree)	0	360	−360	~84 × 10^{-3}°
Example	159.974 365°			
Note	The value obtained by measuring the angle between the direction of the device and the direction of the sensor clockwise from the top of the device. When a value cannot be input, a special value (−360) is used.			

Tag name	GimbalPitchDegree			
Description				Support level (M/O)
Sensor's relative pitch angle to device value				M
Unit	Min value	Max value	Exception value	Resolution
° (Degree)	−180	180	−360	~84 × 10^{-3}°
Example	−0.431 531 724°			
Note	The same direction as the device base is set to 0°, and the top has a positive value and the bottom has a negative value. When a value cannot be input, a special value (−360) is used.			

Tag name	GimbalRollDegree			
Description				Support level (M/O)
Angle of relative roll relative to the device of the sensor				M
Unit	Min value	Max value	Exception value	Resolution
° (Degree)	−180	180	−360	~84 × 10^{-3}°
Example	−3.405 865 66°			
Note	Angle of rotation counterclockwise when looking at the sensor in front of the sensor (lens axis). When a value cannot be input, a special value (−360) is used.			

8.4 Spatial information metadata

Spatial information metadata in the still image are specified in Table 7.

Table 7 – MCSI for spatial information

Tag name	LatitudeOfImageCenter			
Description				Support level (M/O)
Latitude of the ground point corresponding to the image centre point				M
Unit	Min value	Max value	Exception value	Resolution
° (Degree)	−90	90	−360	$\sim 42 \times 10^{-3}$°
Example	−13.542 388 533 146 132°			
Note	When the centre of the image does not pass through the surface of the earth, a special value (−360) is used in reference coordinate system, e.g., global navigation satellite system (GNSS), etc.			

Tag name	LongitudeOfImageCenter			
Description				Support level (M/O)
Longitude of the ground point corresponding to the image centre point				M
Unit	Min value	Max value	Exception value	Resolution
° (Degree)	−180	180	−360	$\sim 84 \times 10^{-3}$°
Example	−29.157 890 122 923 014°			
Note	When the centre of the image does not pass through the surface of the earth, a special value (−360) is used in reference coordinate system, e.g., GNSS.			

Tag name	LatitudeOfImageLT			
Description				Support level (M/O)
The latitude of the ground point corresponding to the top left corner of the image				M
Unit	Min value	Max value	Exception value	Resolution
° (Degree)	−90	90	−360	$\sim 42 \times 10^{-3}$°
Example	−29.157 890 122 923 014°			
Note	When the upper left vertex centre of the image does not pass through the surface of the earth, a special value (−360) is used in reference coordinate system, e.g., GNSS.			

Tag name	LongitudeOfImageLT			
Description				Support level (M/O)
The longitude of the ground point corresponding to the top left corner of the image				M
Unit	Min value	Max value	Exception	Resolution

			value	
° (Degree)	−180	180	−360	~84 × 10^{-3}°
Example	−29.157 890 122 923 014°			
Note	When the upper left vertex centre of the image does not pass through the surface of the earth, a special value (−360) is used in reference coordinate system, e.g., GNSS.			

Tag name	LatitudeOfImageRT			
Description				Support level (M/O)
The latitude of the ground point corresponding to the top right corner of the image				M
Unit	Min value	Max value	Exception value	Resolution
° (Degree)	−90	90	−360	~42 × 10^{-3}°
Example	−13.542 388 533 146 132°			
Note	When the upper right vertex of the image does not pass through the surface of the earth, a special value (−360) is used in reference coordinate system, e.g., GNSS.			

Tag name	LongitudeOfImageRT			
Description				Support level (M/O)
The longitude of the ground point corresponding to the top right corner of the image				M
Unit	Min value	Max value	Exception value	Resolution
° (Degree)	−180	180	−360	~84 × 10^{-3}°
Example	−29.157 890 122 923 014°			
Note	When the upper right vertex of the image does not pass through the surface of the earth, a special value (−360) is used in reference coordinate system, e.g., GNSS.			

Tag name	LatitudeOfImageLB			
Description				Support level (M/O)
The latitude of the ground point corresponding to the lower left vertex of the image				M
Unit	Min value	Max value	Exception value	Resolution
° (Degree)	−90	90	−360	~42 × 10^{-3}°
Example	−13.542 388 533 146 132°			
Note	When the lower left vertex of the image does not pass through the surface of the earth, a special value (−360) is used in reference coordinate system, e.g., GNSS.			

Tag name	LongitudeOfImageLB			
Description				Support level (M/O)
The longitude of the ground point corresponding to the lower left vertex of the image				M
Unit	Min value	Max value	Exception value	Resolution
° (Degree)	−180	180	−360	~84 × 10^{-3}°
Example	−29.157 890 122 923 014°			
Note	When the lower left vertex of the image does not pass through the surface of the earth, a special value (−360) is used in reference coordinate system, e.g., GNSS.			

Tag name	LatitudeOfImageRB			
Description				Support level (M/O)
The latitude of the ground point corresponding to the lower right vertex of the image				M
Unit	Min value	Max value	Exception value	Resolution
° (Degree)	−90	90	−360	~42 × 10^{-3}°
Example	−13.542 388 533 146 132°			
Note	When the lower right vertex of the image does not pass through the surface of the earth, a special value (−360) is used in reference coordinate system, e.g., GNSS.			

Tag name	LongitudeOfImageRB			
Description				Support level(M/O)
The longitude of the ground point corresponding to the lower right vertex of the image				M
Unit	Min value	Max value	Exception value	Resolution
° (Degree)	−180	180	−360	~84 × 10^{-3}°
Example	−29.157 890 122 923 014°			
Note	When the lower right vertex of the image does not pass through the surface of the earth, a special value (−360) is used in reference coordinate system, e.g., GNSS.			

8.5 Device information metadata

Device information, such as device and task information, is specified in Table 8.

Table 8 – MCSI for device information

Tag name	Mission			
Description				Support level (M/O)
Information to identify performed device tasks				O
Unit	Min value	Max value	Exception value	Resolution
–	4	127	N/A	–
Example				
Note	Record it as a string with a maximum of 127 characters. The internal expression method expresses device mission performance.			

Tag name	PlatformTailNumber			
Description				Support level (M/O)
Device serial number				O
Unit	Min value	Max value	Exception value	Resolution
–	4	127	N/A	–
Example				
Note	Record it as a string with a maximum of 127 characters for each device.			

Tag name	PlatformDesignation			
Description				Support level (M/O)
Device model name				O
Unit	Min value	Max value	Exception value	Resolution
–	4	127	N/A	–
Example				
Note	Record it as a string with a maximum of 127 characters for model name.			

Appendix I

Use case for a building defect monitoring service using autonomous mobile Internet of things devices

(This appendix does not form an integral part of this Recommendation.)

This appendix explains an example of a use case that informs on the location of building defects in three dimensions to a user using IoT sensing devices that are capable of moving about or flying while adjusting angles. In the case of a model that contains 3D spatial information of a structure, generated using an application such as building information modelling (BIM), emergency measures can be taken by identifying in real time the risks to the building structure (falling, shearing, cracking, etc.) or abnormal situations in images obtained from IoT sensing devices.

The IoT sensing metadata standard is necessary to guarantee interoperability in IoT image or video-based applications, and provide value added IoT services through the IoT sensing metadata standard by reducing development time and human costs.

The building defect monitoring service is shown in Figure I.1 and described as follows.

Step 1 – IoT devices acquire sensing information, e.g., mission, image, video, space and time, for the building defect monitoring service.

Step 2 – The IoT metadata system converts acquired mission information, space information and time information into standard metadata, which yields additional information and applies it as metadata for still images or videos.

Step 3 – The IoT metadata system sends still images or videos with metadata to the building defect detection system and the building defect detection system transmits data to the safety management system when detecting defects in the building.

Step 4 – The safety management system detects the defect using BIM from the image metadata from the surface of the building and the location of the building.

Step 5 – The safety management system reports the actual position of defects in the building to the user (administrator) for final action.

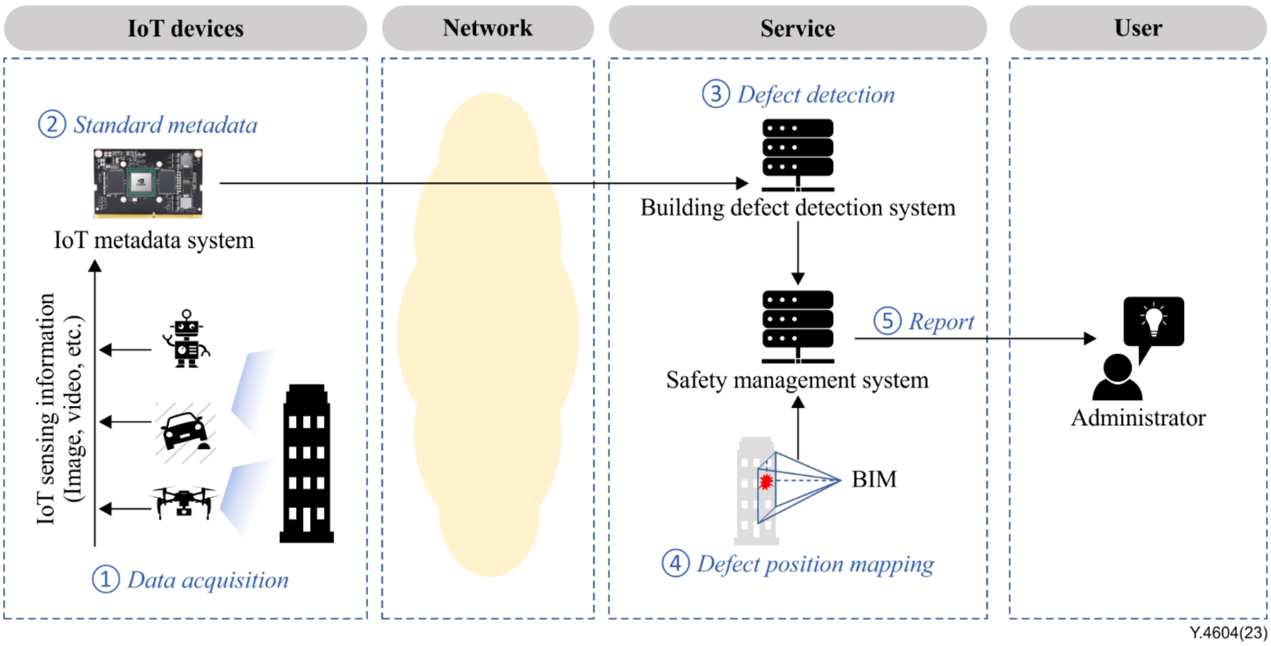

Figure I.1 – Use case of building defect monitoring service using autonomous mobile IoT devices

On the IoT device side of Figure I.1, autonomous mobile IoT conceptual processes may experience additional problems such as:

– differences in specification (units, resolution, criteria);

– lack of common metadata on image sensing information among IoT sensor devices;

– dedicated metadata depending on manufacturer.

As shown in Figure I.2, to resolve these types of problems, it is necessary to specify the minimum metadata that can be commonly provided in IoT camera sensors. These minimum metadata specifications can be used as a foundational image metadata for IoT camera-based services, such as autonomous robot services, building management service and AR/VR services.

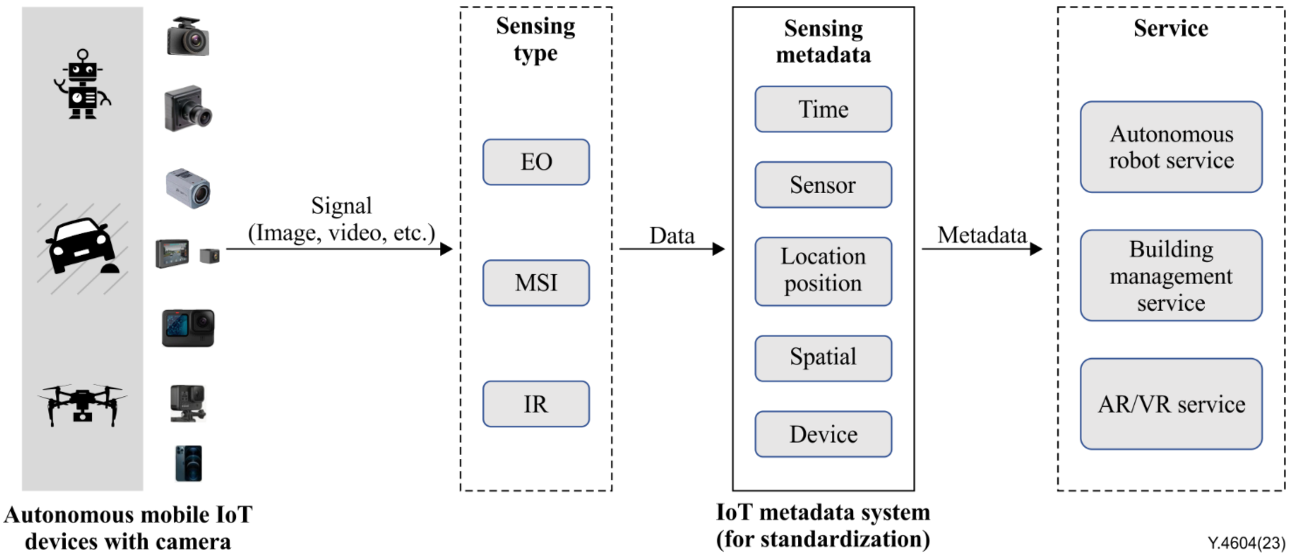

Figure I.2 – Conceptual process for sensing metadata-based service

Table I.1 summarizes major differences between traditional digital camera devices and AMIDs. Generally, existing digital camera devices support full-performance capabilities and high resolution, so the metadata is complex and heavy. However, AMIDs are resource limited and not interchangeable among IoT camera sensors. AMID metadata do not need to cover complex metadata. An AMID is therefore characterized as basic, minimum and lightweight compared to a traditional digital camera device.

Table I.1 – Difference between typical digital camera devices and AMIDs

Metadata	Digital camera device	AMIDs with camera	Description
Time information	Supported	Supported	EXIF, etc.
Sensor specification information	Supported	Supported	EXIF, etc.
Field of view	Calculation as a combination from different sensor specifications	Direct input of calculated values	
Image information	Supported	Supported	EXIF, etc.
Image spatial information	Not supported	Supported	
Location/Position information	Supported in part	Supported	
Location of attachment	Supported	Supported	EXIF, etc.
Position of attachment	Not supported	Supported	
Location of sensor	Not supported	Supported	
Position of sensor	Not supported	Supported	
Device information	Not supported	Supported	

Bibliography

[b-ITU-T Y.1901] Recommendation ITU-T Y.1901 (2009), *Requirements for the support of IPTV services*.

[b-ITU-T Y.2091] Recommendation ITU-T Y.2091 (2011), *Terms and definitions for next generation networks*.

[b-ITU-T Y.4000] Recommendation ITU-T Y.4000/Y.2060 (2012), *Overview of the Internet of things*.

[b-ITU-T Y.4900] Recommendation ITU-T Y.4900/L.1600 (2016), *Overview of key performance indicators in smart sustainable cities.*

[b-ISO 19130-1] International Standard ISO 19130-1:2018, *Geographic information – Imagery sensor models for geopositioning – Part 1: Fundamentals*.

[b-Exif] Hedley, J. (2023). *Exifinfo.org: An online tool to analyze and display the metadata in images and other media files*. Available [viewed 2023-10-07] at: https://exifinfo.org/

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